REMARKS

The present application was filed on September 17, 1999 with claims 1 through 22. Claims 1 through 22 are presently pending in the above-identified patent application. The present amendment proposes to amend each of the independent claims 1, 7, 13, and 18.

In the Office Action, the Examiner provisionally rejected claims 1-4, 7-9, 10, 13-15, and 18-20 under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1, 2, 7-10, 15-18, 22-25, 29, and 30 of co-pending Application No. 09/398,503. The Examiner rejected Claims 1-4, 6-10, 12-15, 17-20, and 22 under 35 U.S.C. § 102(b) as being anticipated by Seki et al. (United States Patent No. 5,771,224). The Examiner also rejected Claims 5, 11, 16, and 21 under 35 U.S.C. § 103(a) as being unpatentable over Seki et al. in view of Sonnenschein et al (United States Patent No. 6,130,859).

The present invention is directed to a terrestrial repeater for use in a satellite transmission system that may also include a plurality of satellites. The OFDM terrestrial repeaters differentially encode the transmitted signal over frequency, as opposed to time, in order to avoid channel phase distortion.

Double Patenting

The Examiner provisionally rejected claims 1-4, 7-9, 10, 13-15, and 18-20 under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1, 2, 7-10, 15-18, 22-25, 29, and 30 of co-pending Application No. 09/398,503. The Examiner asserts that, although the conflicting claims are not identical, they are not patentably distinct from each other because both applications are drawn to an orthogonal frequency division multiplexing OFDM system with an encoder and decoder for modulating and demodulating an OFDM signal and a transformer for creating an OFDM signal having a plurality of carriers.

Applicants respectfully assert that the Double Patenting rejection is improper and requests that the rejections be withdrawn, since each of the claims of the current application require differentially encoding/modulating or decoding/demodulating in the frequency domain and each of the claims of co-pending Application No. 09/398,503 require transmitting an identifying signal on

inactive sub-carriers. These differences are not obvious from one another. In addition, Applicants note that each of these patent applications were filed on the same day and that any patents issued thereon will expire on the same day.

Independent Claims 1, 7, 13, and 18

The Examiner rejected independent Claims 1, 7, 13, and 18 under 35 U.S.C. § 102(b) as being anticipated by Seki et al. (United States Patent No. 5,771,224).

Regarding claims 1 and 7, the Examiner asserts that Seki discloses an "orthogonal frequency division multiplexing OFDM transmitter (FIG. 8) for transmitting an OFDM signal comprising a differential encoder 42 (col.13, lines 29-33) for modulating said OFDM signal in the frequency domain and a transformer 14 (col. 8, lines 47-52) for creating said OFDM signal."

Regarding claims 13 and 18, the Examiner asserts that Seki discloses an "orthogonal frequency division multiplexing OFDM receiver (Fig. 9) for receiving an OFDM signal comprising a transformer 24 (col. 9, lines 34-37) for recovering said OFDM signal having a plurality of sub-carriers and a differential decoder 52 (col. 13, lines 56-62) for demodulating said OFDM signal in the frequency domain."

Applicant notes that Seki is directed to an "orthogonal frequency division multiplexing transmission system...which permits *multi-valued* modulated symbols to be demodulated successfully at the receiving end, even in fading environments." Col.1, line 67 to Col.2, line 4. Regarding the multi-valued QAM modulation method utilized by Seki, Seki teaches that "it is impossible to transmit data in the form of a phase difference between symbols and, at the receiving end, to demodulate data by the differential detection." Col. 1, lines 49-52. Seki does teach that, in a fifth transmission system, "PSK information symbols are subjected to differential coding using the reference symbols as the basis for the differential coding." Col. 2, lines 46-48. The PSK (QPSK) symbols, however, are principally utilized for equalization purposes. Seki et al. teach "the QPSK (PSK) information symbols are inserted at regular intervals for transmission and, in the receiver, amplitude and phase variations detected by the QPSK information symbols are used to interpret amplitude and phase variations of the multi-valued QAM information symbols." Col. 12, lines 5-10.) Thus, the differentially encoded QPSK symbols are interspersed among the non-differentially encoded QAM symbols, as is illustrated in FIG. 7. The differential encoding is not

performed on symbols assigned to adjacent frequencies. Independent claims 1, 7, 13, and 18, as amended, require differential encoding and/or decoding that "is performed between adjacent frequencies of said OFDM system".

Thus, Seki teaches away from the present invention by teaching to utilize multi-valued QAM symbols which cannot be differentially encoded and by teaching to insert differentially encoded QPSK symbols in non-adjacent frequencies. Thus, Seki does not disclose or suggest differential encoding (or decoding) that "is performed _using adjacent sub-carriers" of an OFDM system" as required by each of independent claims 1, 7, 13, and 18, as amended.

Additional Cited References

Sonnenschein (United States Patent 6,130,859) was also cited by the Examiner in rejecting claims 5, 11, 16, and 21 for its disclosure that Sonnenschein discloses "an OFDM transmitter and receiver for transmitting and recovering at least one unmodulated carrier (col. 4, lines 44-55)." Applicants note that Sonnenschein is directed to "an underwater apparatus for transmitting and receiving high rate data and voice communication including a transmitter, a receiver, and a Doppler frequency shift compensator." See, Abstract. Soonenschein teaches utilizing differential encoding in the time domain, as illustrated in Fig. 2. Sonnenchein teaches "a serial (original) data is inputted into the FEC encoder 5, which combines with it additional bits for enabling error correction at the receiving modem. From the FEC encoder 5, the data in serial form is conveyed to a serial to parallel device 12, essentially a shift register, which divides each section of 62 bits of serial data...into 31 two-bit symbols of data to be processed in parallel." Col. 7, lines 52-59. All of the 31 two-bit symbols created by the FEC encoder 5 "are conveyed to 31 differential encoders." Col. 8, lines 17-18.

Thus, Sonnenschein does not disclose or suggest differential encoding and/or decoding that "is performed _using adjacent sub-carriers" of an OFDM system" as required by independent claims 1, 7, 13, and 18, as amended.

Dependent Claims 2-6, 8-12, 14-17 and 19-22

Dependent Claims 2-4, 6, 8-10, 12, 14-15, 17, 19-20, and 22 were rejected under 35 U.S.C. § 102(b) as being anticipated by Seki et al. (United States Patent No. 5,771,224) and dependent Claims 5, 11, 16, and 21 were rejected under 35 U.S.C. § 103(a) as being unpatentable

over Seki et al. in view of Sonnenschein et al (United States Patent No. 6,130,859). Claims 2-6, 8-12, 14-17, and 19-22 are dependent on Claims 1, 7, 13, and 18, respectively, and are therefore patentably distinguished over Seki and Sonnenschein (alone or in any combination) because of their dependency from amended independent Claims 1, 7, 13, and 18 for the reasons set forth above, as well as other elements these claims add in combination to their base claim.

All of the pending claims, i.e., claims 1 through 30, are in condition for allowance and such favorable action is earnestly solicited.

If any outstanding issues remain, or if the Examiner has any further suggestions for expediting allowance of this application, the Examiner is invited to contact the undersigned at the telephone number indicated below.

The Examiner's attention to this matter is appreciated.

Respectfully submitted,

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VERSION MARKED TO SHOW ALL CHANGES

IN THE SPECIFICATION:

Please amend the paragraph beginning at page 1, line 24, as follows:

Satellite broadcasting system[s] transmits digital music and other audio information from an uplink station to one or more mobile receivers. Satellite broadcasting systems typically include a plurality of satellites and terrestrial repeaters operating in a broadcast mode. The satellites are typically geo-stationary, and are located over a desired geographical coverage area. The terrestrial repeaters typically operate in dense urban areas, where the direct line of sight (LOS) between the satellites and the mobile receiver can be blocked due to the angle of elevation and shadowing by tall buildings.

Please amend the paragraph beginning at page 2, line 1, as follows:

It has been observed that the communication channels in such satellite broadcasting systems, and in digital audio broadcasting [(DAB)] systems generally, are often less dispersive in frequency than in time. Nonetheless, digital audio broadcasting [(DAB)] systems typically differentially encode the transmitted signal over time. The European digital audio broadcasting [(DAB)] standard, for example, set forth in "Radio Broadcasting Systems: Digital Audio Broadcasting (DAB) to Mobile, Portable and Fixed Receivers," European Telecommunications Standard: ETS 300 401 (May 1997), performs differential modulation over time. A need therefore exists for a terrestrial repeater that performs differential modulation over frequency. A further need exists for a terrestrial repeater that utilizes an orthogonal frequency division multiplexing [(OFDM)] scheme to implement differential encoding over frequency.

Please amend the paragraph beginning at page 5, line 5, as follows:

In the illustrative embodiment, each OFDM symbol of duration Ts will be composed of 978 active bins (sub-carriers) equally spaced, at a carrier spacing of 4 kHz (Δf). The duration of

the symbol, Ts, is 266.11 mu-sec, where Ts equals Tu plus Tg. [the] The useful OFDM symbol duration, Tu, illustratively equals 250 mu-sec and is, and the guard interval duration or cyclic prefix duration, Tg, illustratively equals 16.11 mu-sec. The inter-carrier spacing, Δf, of 4KHz is equal to the inverse of the useful symbol duration (1/Tu). The main signal is defined as follows:

$$s(t) = \mathrm{Re}\left\{ \sum_{l=-\infty}^{\infty} \left(\sum_{k=-489}^{489} z(l,k) \times g(t - lTs, l, k) + \sum_{k=-511}^{-490} m(533+k) g(t - lTs, l, k) + \sum_{k=490}^{511} m(k-490) g(t - lTs, l, k) \right) \right\}$$

where [,] z(l,k) equals the differentially coded complex symbol for to the kth sub-carrier in the lth OFDM symbol for k != 0 and 0 for k = 0; m(k) equals the complex TII information (transmitted only in the TII mode, 0 in normal mode); g(t, l, k) = exp(j*2*π*k*(t-Tg)/Tu)*rect(t/Ts) for all l; and rect(x) = 1 for 0<=x<1 or 0 otherwise. In addition, where the *Factor* equals two (2), T is defined as (1/(2048*4000)) (approximately 122.07 ns); Tg is defined as approximately 16.11 mu-sec (= 132T); Tu is defined as 250 mu-sec = 2048T and Ts is defined as approximately 266.11 mu-sec (= 2180T).

IN THE CLAIMS:

Please amend the claims as indicated below:

1. (Amended) A method of transmitting a signal in an orthogonal frequency division multiplexing (OFDM) system having a plurality of sub-carriers, comprising the steps of:

differentially encoding said signal in the frequency domain using adjacent sub-carriers; and

transforming said differentially modulated signal to create said OFDM signal.

2. The method of claim 1, wherein said transforming step implements a Fast Fourier Transform.

3. The method of claim 1, wherein said transforming step implements an orthogonal transformation.

4. The method of claim 1, wherein said transforming step generates said OFDM signal with a plurality of sub-carriers for carrying data.

5. The method of claim 4, wherein at least one unmodulated sub-carrier generated by said transforming step is allocated as a pilot bin to provide a reference within each OFDM symbol.

6. The method of claim 4, wherein said differential encoding is performed with respect to consecutive sub-carriers in said OFDM system.

7. (Amended) An orthogonal frequency division multiplexing (OFDM) transmitter for transmitting an OFDM signal having a plurality of sub-carriers, comprising:

a differential encoder for modulating said OFDM signal in the frequency domain using adjacent sub-carriers; and

a transformer for creating said OFDM signal.

8. The transmitter of claim 7, wherein said transformer implements a Fast Fourier Transform.

9. The transmitter of claim 7, wherein said transformer implements an orthogonal transformation.

10. The transmitter of claim 7, wherein said transformer generates said OFDM signal with a plurality of sub-carriers for carrying data.

11. The transmitter of claim 10, wherein at least one unmodulated sub-carrier generated by said transforming step is allocated as a pilot bin to provide a reference within each OFDM symbol.

12. The transmitter of claim 10, wherein said differential encoding is performed with respect to consecutive sub-carriers in said OFDM system.

13. (Amended) A method of receiving a signal in an orthogonal frequency division multiplexing (OFDM) system having a plurality of sub-carriers, comprising the steps of:

transforming said received signal to recover an OFDM signal in the frequency domain having a plurality of sub-carriers; and

differentially decoding said OFDM signal in the frequency domain wherein said differential decoding is performed using adjacent sub-carriers.

14. The method of claim 13, wherein said transforming step implements a Fast Fourier Transform.

15. The method of claim 13, wherein said transforming step implements an orthogonal transformation.

16. The method of claim 13, wherein at least one unmodulated sub-carrier recovered by said transforming step is allocated as a pilot bin to provide a reference within each OFDM symbol.

17. The method of claim 13, wherein said differential decoding is performed with respect to consecutive sub-carriers in said OFDM system.

18. (Amended) An orthogonal frequency division multiplexing (OFDM) receiver for receiving an OFDM signal having a plurality of sub-carriers, comprising:

a transformer for recovering said OFDM signal having a plurality of sub-carriers; and

a differential decoder for demodulating said OFDM signal in the frequency domain wherein said differential decoding is performed using adjacent sub-carriers.

19. The receiver of claim 18, wherein said transformer implements a Fast Fourier Transform.

20. The receiver of claim 18, wherein said transformer implements an orthogonal transformation.

21. The receiver of claim 18, wherein at least one unmodulated sub-carrier recovered by said transformer is allocated as a pilot bin to provide a reference within each OFDM symbol.

22. The receiver of claim 18, wherein said differential decoder demodulates said OFDM signal with respect to consecutive sub-carriers in said OFDM system.